FLUKE®

Instruction Manual

NOTE

This manual documents the 8600A-521 and the 8600A-529 DMM Interface Options and their assemblies at the revision levels shown in Manual Change Information. If your interface contains assemblies with different revision letters, it will be necessary for you to either update or backdate this manual. Refer to the supplemental change/errata sheet for newer assemblies or to the backdating sheet in Manual Change Information.

Property of
FLUKE SERVICE CENTER
Dallas, Texas

Model

8600A -521/-529

DMM Interface Options

P/N 530824

September 1979

WARRANTY

Notwithstanding any provision of any agreement the following warranty is exclusive:

The JOHN FLUKE MFG. CO., INC., warrants each instrument it manufactures to be free from defects in material and workmanship under normal use and service for the period of 1-year from date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses, disposable batteries (rechargeable type batteries are warranted for 90-days), or any product or parts which have been subject to misuse, neglect, accident or abnormal conditions of operations.

In the event of failure of a product covered by this warranty, John Fluke Mfg. Co., Inc., will repair and calibrate an instrument returned to an authorized Service Facility within 1 year of the original purchase; provided the warrantor's examination discloses to its satisfaction that the product was defective. The warrantor may, at its option, replace the product in lieu of repair. With regard to any instrument returned within one year of the original purchase, said repairs or replacement will be made without charge. If the failure has been caused by misuse, neglect, accident or abnormal conditions of operations, repairs will be billed at a nominal cost. In such case, an estimate will be submitted before work is started, if requested.

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2. On receipt of the shipping instructions, forward the instrument, transportation prepaid. Repairs will be made at the Service Facility and the instrument returned, transportation prepaid.

SHIPPING TO MANUFACTURER FOR REPAIR OR ADJUSTMENT

All shipments of JOHN FLUKE MFG. CO., INC., instruments should be made via United Parcel Service or "Best Way" prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid and of adequate size. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT TO ORIGINAL PURCHASER

The instrument should be thoroughly inspected immediately upon original delivery to purchaser. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument is damaged in any way, a claim should be filed with the carrier immediately. (To obtain a quotation to repair shipment damage, contact the nearest Fluke Technical Center.) Final claim and negotiations with the carrier must be completed by the customer.

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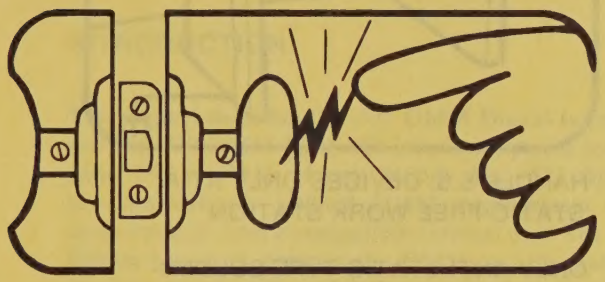
static awareness

A Message From

John Fluke Mfg. Co., Inc.

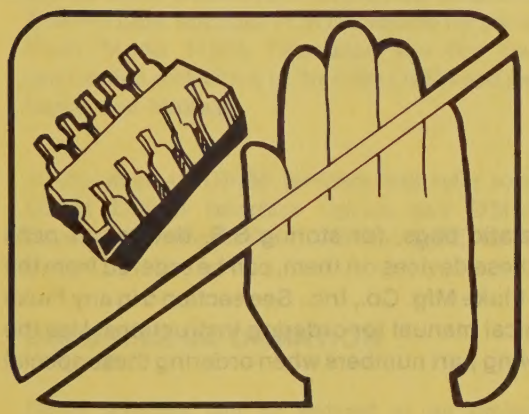


Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

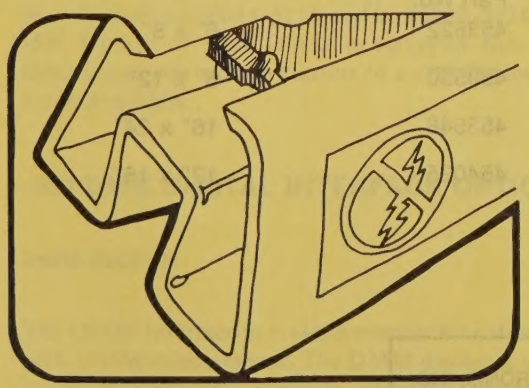
1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol "⊗".

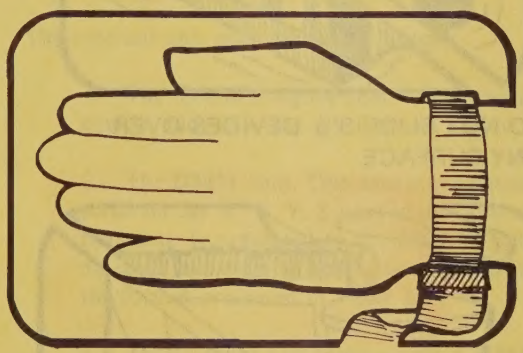
The following practices should be followed to minimize damage to S.S. devices.



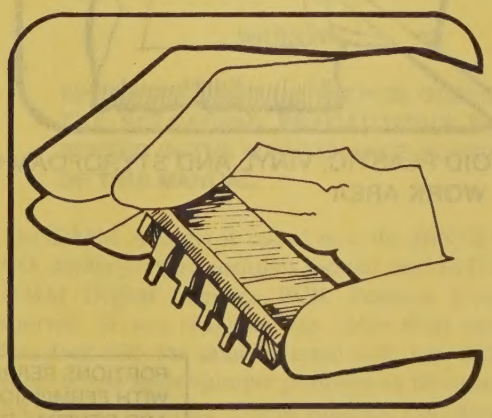
1. MINIMIZE HANDLING



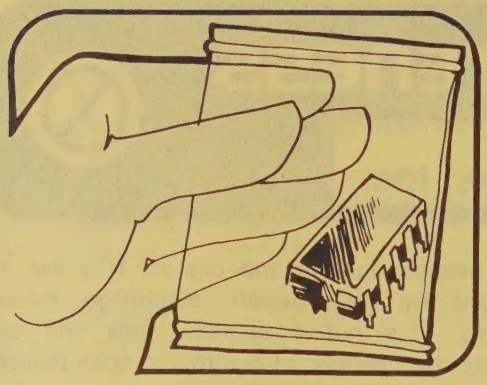
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



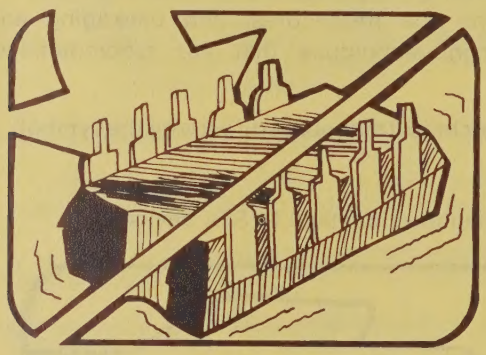
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES



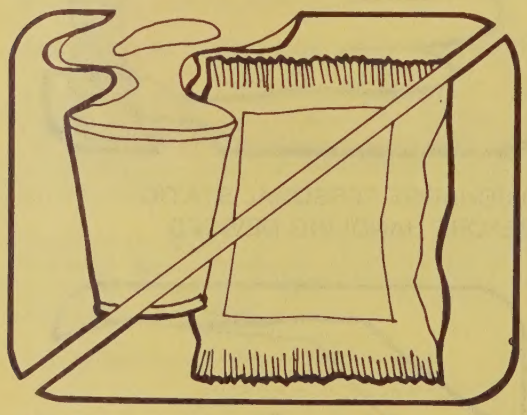
4. HANDLE S.S. DEVICES BY THE BODY



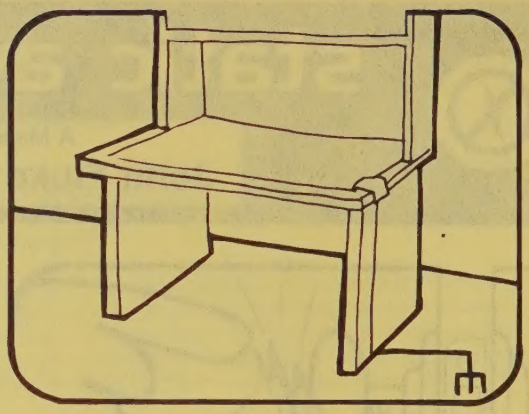
5. USE ANTI-STATIC CONTAINERS FOR HANDLING AND TRANSPORT



6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE



7. AVOID PLASTIC, VINYL AND STYROFOAM® IN WORK AREA



8. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION

9. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.

10. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED.

Anti-static bags, for storing S.S. devices or pcbs with these devices on them, can be ordered from the John Fluke Mfg. Co., Inc.. See section 5 in any Fluke technical manual for ordering instructions. Use the following part numbers when ordering these special bags.

John Fluke Part No.	Bag Size
453522	6" x 8"
453530	8" x 12"
453548	16" x 24"
454025	12" x 15"

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WARNING

OBSERVE THE PRECAUTIONS ON THE STATIC AWARENESS SHEET WHEN HANDLING THE PCB ASSEMBLIES OF THESE OPTIONS.

INTRODUCTION

This manual describes the -521 DMM Digital Interface and the -529 DMM-IEEE-488 Interface Options for the John Fluke DMM Models 8600A. The -521 Option provides optically isolated DMM measurement data upon demand from a compatible external unit. The -529 Option translates between the DMM and the General Purpose Interface Bus (GPIB) as defined in the IEEE Standard 488-1978. The -529 Option is composed of one -521 Option and one DMM-1120A Interface PCB (8600A-522K). (A maximum of 10 DMMs or DVMs -- each with their own -521 Option -- can be connected to one DMM-1120A Interface PCB. Use the John Fluke Model Y2034 Interconnect Accessory for the physical connection.) The DMM-1120A Interface PCB is intended for use in a John Fluke Model 1120A Translator. Use this manual in conjunction with either or both the DMM and the 1120A Instruction Manuals.

In this manual, DMM Interface will refer to the -521 DMM Digital Interface Option and DMM-GPIB Interface will refer to the -529 DMM-IEEE-488 Interface Option.

ORDERING INFORMATION

Either interface can be ordered as an option when ordering your DMM. If you have the DMM and want either option, order kit 8600A-521K for the -521 Option or order both kit 8600A-521K and kit 8600A-522K for the -529 Option. If your DMM is equipped with a -521 Option and you wish to convert to a -529 Option, order kit 8600A-522K.

-521 DMM DIGITAL INTERFACE OPTION

Introduction

The DMM Interface provides a compatible external unit with DMM measurement. The DMM display is updated if the external unit properly addresses the interface (DMM Address). The following paragraphs describe the compatibility requirements of the external unit and how to operate the DMM Interface through the external unit.

Specifications

Table 1 lists the specifications of the DMM Interface.

THE EXTERNAL UNIT

The external unit must be able to provide:

1. Operating Power (GND and +5V dc at 10 mA).

2. DMM Address: the proper DMM Address must be maintained on the address lines (A0-A4) as long as DMM data is desired. If the DMM Address is changed or transmission is stopped, the DMM Interface will stop communication.

The external unit must be able to accept:

1. The DMM's signal that it has received the correct address -- the AV line will go low.

2. The DMM data. This data is presented nibble-serial on the W, X, Y, Z lines in the same sequence that data is presented to the DMM display. The external unit must be able to use the DMM data in the format presented in Table 2.

3. The external unit must accept a DMM data-nibble when, and only when, the DV line goes low.

Changing the DMM Address

WARNING

WHEN SOLDERING ON THE PCB, OBSERVE THE SOLDERING PRECAUTIONS PRESENTED IN THE MAINTENANCE PORTION OF THIS MANUAL.

The DMM Address is coded into the INSTRUMENT NO. solder-jumper positions located next to U11 on the DMM Digital Interface PCB. Position 1 should be shorted. If you want to use more than one DMM Interface with the same external unit, you will have to short across solder-jumper positions so that each DMM Interface has a unique DMM Address. For compatibility with the -529 Option, use only addresses 1, 2, and 3. Insure that there is a jumper between points E1 and E2 on the DMM Digital Interface PCB.

Table 1. DMM Digital Interface Specifications

MECHANICAL:

Connector Type: 36-pin AMP "Blue Ribbon Type" series connector. DMM connector is female. Compatible external unit connector is male.

Pin Identification:

PIN NO.	MNEMONIC	SOURCE		DESCRIPTION
		DMM	EXT UNIT	
1	$\overline{AV}$	X		Not Address Valid - Low indicates DMM is responding to a valid address.
2	$\overline{DV}$	X		Not Data Valid - Low indicates that DMM data on W, X, Y, Z is valid.
3	A0		X	LSB } DMM Address
4	A1		X	
5	A2		X	
6	A3		X	MSB
7 & 8	NOT USED			
9	Z	X		LSB } BCD DMM data transmitted nibble-serial.
10	Y	X		
11	X	X		
12	W	X		MSB
13-16	NOT USED			
17	GND		X	Operating voltages for interface side of DMM Digital Interface PCB circuitry.
18	+5V		X	
19-36	NOT USED			

ELECTRICAL:

Timing: DATA NIBBLE* PRESENT ON WXYZ . . . 160 μs
DV . . . . . 80 μs
COMPLETE DATA SEQUENCE . . . . . 1.28 ms

*These are nominal values
DV may be as short as 30 μs.

Optical Isolation: Data transfer reliable up to 500V ac rms common mode voltage from dc to 440 Hz. Opto-isolators rated for 2500V ac rms at 60 Hz.

Physical Distance between Devices: Less than 3 meters (approximately 10 feet).

Voltage Levels: Based on CMOS technology with +5V power supply and allowance for pull-up resistors.

Logic Levels: Positive-true.

High State: 3.5 to 5V.

Low State: 0 to 1.0V.

Drivers: Tri-state devices with active true signals and 470Ω series resistors.

STATE	OUTPUT VOLTAGE
High	4.6 to 5V at –0.14 mA
Low	0 to 0.7V at +0.36 mA
Off	Maximum leakage current is ±20 μA

Receivers: Resistive terminal is 100 kΩ tied to +5V only. Maximum leakage current of receiver is ±20 μA.

STATE	INPUT VOLTAGE
High	3.5 to 5V
Low	0 to 1.5V

Operating Power: Two +5V and GND sources.

+5V and GND supplied by DMM to DMM side of the DMM Digital Interface PCB circuitry.

+5V at less than 10 mA and GND are supplied to the interface side of the DMM Digital Interface PCB circuitry via the interface cable.

Table 2. DMM Data Format on the DMM Digital Interface

DATA FORMAT TABLE

SEQUENCE NO.	W	X	Y	Z	MEANING
1	OL	a	b	c	Status/Range
2	B	B	B	B	4SD
3	P	$\overline{(P+Z1)}$	$\overline{P}$	$\overline{Z1}$	Polarity/MSD (-)
4	Z1	0	Z1	$\overline{Z1}$	MSD (+)
5	B	B	B	B	5SD
6	B	B	B	B	2SD
7			NULL	DATA	
8	B	B	B	B	3SD

RANGE TABLE

abc	RANGE
000	not used
001	200Ω
010	2 kΩ
011	20 kΩ
100	200 kΩ
101	2000 kΩ
110	20 MΩ
111	not used

0	binary bit:	logic 0, low
1	binary bit:	logic 1, high
abc	binary range code:	(see inset Range Table)
B	binary data bit:	0 or 1
DV	Data Valid	low on DV line indicates valid data on WXYZ
K	If K = 1:	DMM will flash decimal point for underload and flash all digits for inputs greater than 700V.
MSD	Most Significant Digit 2SD follows MSD in significance	
OL	If OL = 1:	Overload - DMM input has exceeded capacity for that range.
UL	If UL = 1:	Underload - DMM is below optimum for that range and reading may not be accurate.

Operation

Connect the DMM to the external unit using the interface cable. Use the following procedures to operate the interface:

1. To begin DMM Communications:

   a. Engergize the DMM and the external unit and set the controls of both to the proper positions for the DMM measurements desired.

   b. Connect the DMM to the points that are to be measured.

   c. Cause the external unit to send the proper DMM Address continuously.

2. To end DMM Communications:

   Cause the external unit to stop sending the DMM Address or to send a different DMM Address.

Theory of Operation

The DMM Digital Interface PCB (schematic at the rear of this manual) is used to provide electrical isolation between the instrument and the interface data outputs. Power (+5V dc) is supplied from the instrument for driving its side of the interface. The output side must be supplied with +5V dc by the user or the 1120A. Figure 1 shows the signals present in the instrument and the interface which help transfer the data. DMM data is presented nibble-serial, bit-parallel, on the W, X, Y, Z data lines. Each BCD digit in the instrument has an associated strobe. In the middle of the strobe, RG provides an edge-protected pulse for clocking the data into a latch. Once each measurement cycle -- when a new value is first available -- BZ goes high for one strobe raster. BZ is clocked into flip-flop 2 of U2 by one of the strobes. This provides a delay so that the first data-nibble output from the DMM Digital Interface may be selected by the choice of strobe on the clock input. Q2 is connected to R1 so that when Q2 is high, Q1 follows S1, but when Q2 is low, Q1 remains high. In this way, only one strobe raster of RG pulses is sent out on Q1 each measurement cycle. U1 provides current drive for the LEDs in the opto-isolators U3-U8.

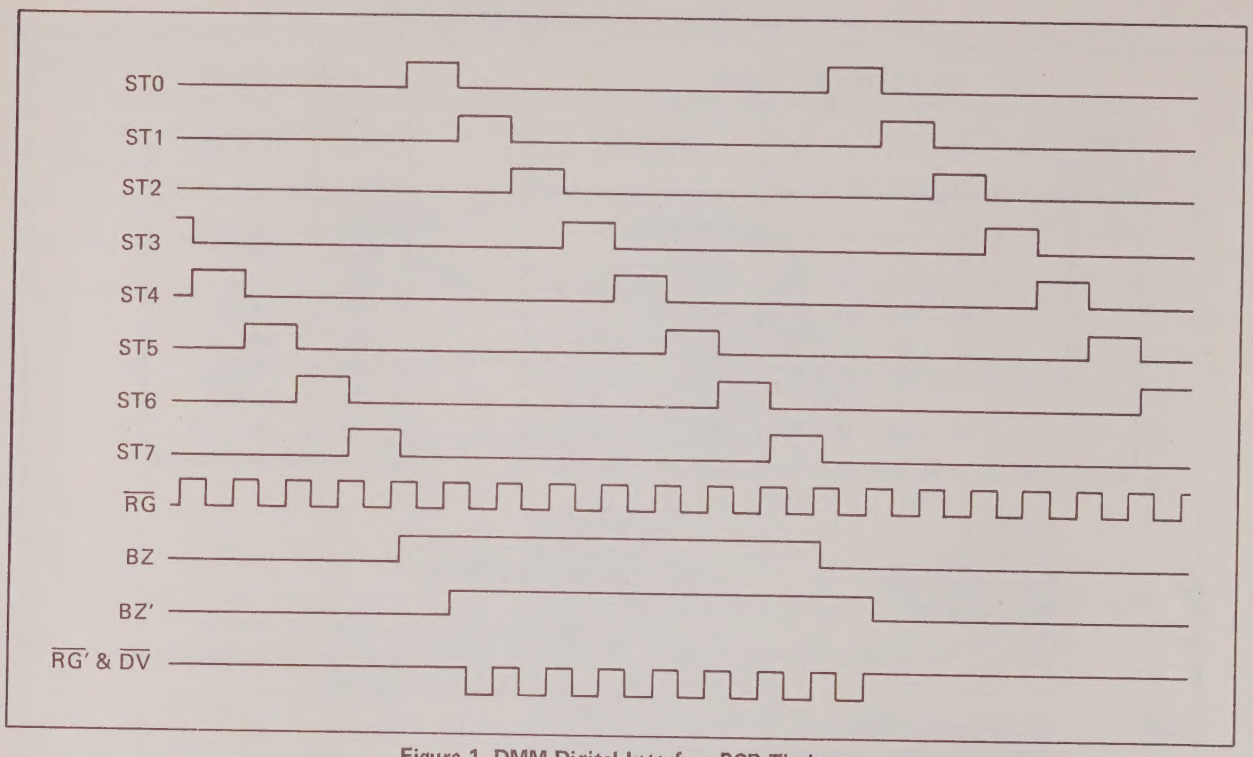


Figure 1. DMM Digital Interface PCB Timing

The guard lands on the PCB (illustrated on the schematic by dashed lines up through the opto-isolators) prevent noise from being passed back into the instrument from the output side and aid reliable data transfer at high common mode voltages and frequencies.

When the opto-isolator LEDs turn on, the output transistors are driven into saturation (turn on). The 100 kΩ base resistors speed up turn-off by bleeding off charge stored in the transistor base region. When the BCD number present on A3-A0 does not match the jumper selected INSTRUMENT NO., U11 (a 1-of-10 decoder) puts a high on U9 pin 15 tri-stating the AV and DV lines. The high on U10 pins 1 and 8 causes U10 pin 4 to be high, tri-stating U9 data buffers for W, X, Y, Z.

When the instrument number is selected on A3-A0, AV goes low and DV goes high. The RS flip-flop formed by U10 is designed to prevent output of a partial data sequence. U10 pin 4 will not got low, enabling data lines, W, X, Y, Z and allowing RG' to control DV, until both U10 pins 8 and 9 are low. If the instrument number is applied during BZ', no DV pulses will be output until the end of the next measurement cycle. A time delay (R27 and C2) gives the microprocessor time to enable its interrupt after addressing a DMM. Data will be present on W, X, Y, and Z continuously after U10 pin 4 goes low. R13-R26 provide limited protection for CMOS parts U9 and U11.

-529 DMM-IEEE-488 INTERFACE OPTION

Introduction

The -529 DMM-IEEE-488 Interface Option is composed of one -521 DMM Digital Interface Option and one DMM-1120A Interface PCB. Material relating to the -521 Option appears earlier in this manual. The DMM-1120A Interface PCB must be installed in a John Fluke Model 1120A Translator. The 1120A Instruction Manual contains information on operating the 1120A with the GPIB and instructions for installing the DMM-1120A Interface PCB. The following paragraphs contain the information necessary to operate the -529 Option as an interface between the DMM and the GPIB.

Specifications

Table 3 lists the specifications -- including the GPIB format of DMM data -- for the -529 Option.

Programming Alternatives

You are provided with programming alternatives by the position of 1120A front panel controls; the position of the DMM-1120A Interface PCB inside the 1120A; and by the INSTRUMENT TYPE/ADDRESS, TALK ONLY, and SUPPRESS ALPHA solder-jumper positions on the DMM-1120A Interface PCB. The following paragraphs detail each of these alternatives.

Table 3. DMM-IEEE Interface Specifications

DMM RELATED SPECIFICATIONS:

All DMM related specifications are listed in the DMM Digital Interface Specifications, Table 1.

GPIB RELATED SPECIFICATIONS:

Electrical: See 1120A Instruction Manual

Mechanical: See 1120A Instruction Manual

Software:

Interface Functions Implemented:

SH1	(Source Handshake) Interface Function
AH1	(Acceptor Handshake) Interface Function
T3	(Talker) Interface Function Including Talk Only
TE3	(Extended Talker) Interface Function
L0	(Listener) no capability
SR0	(Service Request) no capability
RL0	(Remote Local) no capability
PP0	(Parallel Poll) no capability
DC0	(Device Clear) no capability
DT0	(Device Trigger) no capability
C0	(controller) no capability

Approximate source handshake data rate: 8900 bytes/sec.

Approximate acceptor handshake data rate: 3000 bytes/sec.

Message Transmission Rate: One message can be sent each measurement cycle of the addressed DMM.

Data Format: All data sent in ASCII.

FORMAT	EXAMPLE MESSAGES
[+/-]D.D.D.D.D.[E+/-D] [,<alpha>] <CR><LF,END> Where <alpha> = space/>	+5.000, -0.10E-, +19.765E+3, +188.88, >

1. MNEMONICS

+/–	Polarity sign, if used.
C	ASCII character - alpha or numeric.
D	Digit - most leading zeros are not sent.
.	Possible decimal point location.
E+/–D	Exponent in engineering units; D is in multiples of 3. If D = 0, the exponent portion is not sent.
<CR>	Carriage return - ASCII 13.
<LF,END>	Line feed - ASCII 10, sent simultaneously with END-GPIB single line message on EOI.
<number>	A sequence of ASCII characters representing a numerical value.
<alpha>	A sequence of ASCII alphabetical characters.
>	Overload.
<	Underload.
[]	Characters in brackets are optional.
/	Indicates choice of characters.

2. The optional non-numeric ,<alpha> portion of the measurement data messages may be suppressed (not sent by shorting the SUPPRESS ALPHA solder jumper on the DMM-1120A Interface.

Table 3. DMM-IEEE Interface Specifications (cont)

Instrument Related Timing:*	
DATA TRANSFER AND CONVERSION	2 ms
CYCLE TIME	400 to 575 ms Nominal, 600 to 775 ms Overload

WHERE:

* Cycle time is the time the instrument requires to make one measurement.

Data Transfer and Conversion time is the ime required for the instrument to transfer data to the microprocessor plus time for the microprocessor to reformat data before it can be sent on the GPIB, If ATN is asserted by a controller during the data transfer and conversion period, that data is lost.

MY TALK ADDRESS (MTA)

MTA is used in conjunction with My Secondary Address (MSA) to designate one DMM connected through the -529 Option as the GPIB talker. The MTA of a particular -529 Option is determined by the positions of 1120A front panel switches and the position of the DMM-1120A Interface PCB in the 1120A. Refer to the 1120A Instruction Manual for information on coding MTA.

MY SECONDARY ADDRESS (MSA)

MSA can either be sent by the GPIB Controller or it can be coded on the INSTRUMENT TYPE/ADDRESS solder-jumpers on the DMM-1120A Interface PCB. (If the TALK ONLY solder-jumper position is shorted, MSA must be coded on the INSTRUMENT TYPE/ADDRESS solder jumpers.) MSA corresponds to the DMM Address. The MSA for a factory version of the 8600A-529 Option is an ASCII "h" for DMM Measurement Data. If MSA is coded on the INSTRUMENT TYPE/ADDRESS solder-jumper positions, position 6 and 4 only should be shorted.

TALK ONLY

If the interface is to be used in a "dumb" system, where the interface is to be the only talker on the GPIB (such as when data logging on a printer), short the TALK ONLY solder-jumper position and program MSA on the INSTRUMENT TYPE/ADDRESS solder-jumper positions on the DMM-1120A Interface PCB.

SUPPRESS ALPHA

If you want the alpha or non-numerical portion of the DMM measurement message (shown in the specifications table) to be omitted from the GPIB transmission, short the SUPPRESS ALPHA solder-jumper position on the DMM-1120A Interface PCB. (If your pcb does not have a SUPPRESS ALPHA solder-jumper position, short pin 34 of U1 to ground for the same effect.)

Operating Notes

SERIAL POLL PRECAUTION

Do not attempt to serial poll this interface. If the interface is serial polled, it will send the first byte of its data message (which may include RQS). If the interface is serial polled, untalk the interface (failure to do so may result in the transmission of a partial message).

DMM ADDRESS ERROR MESSAGE

If the DMM is incorrectly addressed, the DMM-GPIB Interface may respond with the following error message: ER<CR><LF,END>

OPERATION WITH ONE DMM

Insure that all the instruments are properly connected and programmed and that all instrument controls are in the proper positions. Use the following example as a guide to interface operation:

Given: MTA is an ASCII A.

DMM input is +5.0V ac rms.

DMM controls are set to the following positions:

POWER	ON
ACV	in
20	in

1. To establish DMM communications with position 6 of the INSTRUMENT TYPE/ ADDRESS shorted (MSA coded on the DMM-1120A Interface PCB), cause the GPIB Controller to send: ATN<A><LISTENER ADDRESS>

2. To establish DMM communications with position 6 of the INSTRUMENT TYPE/ ADDRESS open, cause the GPIB Controller to send:

a. ATN<A><h><LISTENER ADDRESS>

b. The message from the DMM-IEEE Interface should be +5.000,<CR><LF END>

3. To end DMM communications, cause the GPIB Controller to send ATN< >, which is the Untalk command.

OPERATION WITH MORE THAN ONE DMM

NOTE

If DMM models other than 8600A are connected to the same interface as your 8600A, conflicts in DMM Addresses may arise. See Table 4 to avoid DMM Address conflicts.

One DMM-1120A Interface PCB can interface up to 10 DVMs or DMMs (each equipped with a -521 DMM Digital Interface Option). Up to four of these 10 may be 8600A Model DMMs. Table 4 lists the four DMM Addresses and the corresponding MSAs that are allocated to 8600A DMMs. Once the addressing has been selected, to get DMM measurement data from a particular DMM, cause the GPIB Controller to send the command string described in Operation With One DMM along with the appropriate MTA, MSA, and LISTENER ADDRESS. To get information from another DMM connected to the same DMM-IEEE Interface, cause the GPIB Controller to send ATN<MSA OF THE NEW DMM>. To stop communications with a particular DMM-GPIB Interface cause the GPIB Controller to send either ATN< > or ATN<ANOTHER TALKER ADDRESS>.

DMM-GPIB Interface Operation Examples

INTRODUCTION

The following operation examples show how various GPIB controllers may be used to collect data from DMMs connected to the DMM-GPIB Interface. The choice of controllers used for the examples does not imply a recommendation.

TEKTRONIX 4051

The basic format for data input is <line #> INPUT @P,S: <variable> where P is the primary talk address of the DMM-1120A Interface PCB and S is the secondary address of the DMM. The primary talk address may be 1 to 31 only as the 4051 will not allow a primary talk address of 0.

Operation with One DMM

In the following examples, the primary talk address is 4 and the DMM is an 8600A measuring a +5.0V ac rms signal. The DMM front panel controls are set to the following positions:

POWER	ON
ACV	in
20	in

The following are three examples of different data types and data presentations that may be requested using the 4051.

1. To get the entire DMM measurement data message, enter the following into the 4051:

```
100 INIT
110 INPUT @4,2:A$
120 PRINT A$
RUN
```

When RUN is entered, the 4051 will initiate the program which will: send IFC on the GPIB; send a primary talk adddress of 4 and a secondary address of 2 then wait for data; when data is presented on the GPIB by the DMM-GPIB Interface, the 4051 will accept and display the DMM data. In this case, the 4051 screen should display "5.000, ".

2. To use the DMM measurement data for further computations, enter the following into the 4051:

```
100 INIT
110 INPUT @4,2:D,A$
120 PRINT D,A$
RUN
```

When RUN is entered, the 4051 will initiate the program which will: send IFC on the GPIB; send a primary talk address of 4 and a secondary talk address of 2, then wait for data. When the DMM-GPIB Interface presents DMM measurement data on the GPIB, the 4051 will read the measurement number as a numeric variable and the remainder of the DMM message as a string A$. In this case, the 4051 screen should display "5.000,".

3. To read only the numeric value of the DMM message, enter the following into the 4051:

```
100 INIT
110 INPUT @4,2:A$
120 PRINT A$
RUN
```

When RUN is entered, the 4051 will initiate the program which will: send IFC on the GPIB; send a primary talk address of 4 and a secondary talk address of 2, then wait for data; when data is presented on the GPIB by the DMM-GPIB Interface, the 4051 will accept the numerical portion and ignore the remainder of the DMM message.

Table 4. MSA and DMM Address Selection for Multiple DMM Operation

INSTRUMENT TYPE		MSA ASCII	MSA 5-BITS IN MSA 5 4 3 INSTRUMENT TYPE	MSA 5-BITS IN MSA 2 1 ADDRESS	DMM ADDRESS A LINE 3 2 1 0	DMM ADDRESS SHORT "INST. NO." POSITION
892XA	Measured Data	'	0 0 0	0 0	0 0 0 0	0
		a	0 0 0	0 1	0 0 0 1	1
		b	0 0 0	1 0	0 0 1 0	2
		c	0 0 0	1 1	0 0 1 1	3
	dB Ref	d	0 0 1	0 0	0 0 0 1	1
		e	0 0 1	0 1	0 0 1 0	2
		f	0 0 1	1 0	0 0 1 1	3
		g	0 0 1	1 1	0 1 0 0	4
8600A		h	0 1 0	0 0	0 0 1 0	2
		i	0 1 0	0 1	0 0 1 1	3
		j	0 1 0	1 0	0 1 0 0	4
		k	0 1 0	1 1	0 1 0 1	5
8810A		p	1 0 0	0 0	0 1 0 0	4
		q	1 0 0	0 1	0 1 0 1	5
		r	1 0 0	1 0	0 1 1 0	6
		s	1 0 0	1 1	0 1 1 1	7

	S5 S4 S3	Instrument Type
+	S2 S1	Address
A3 A2 A1 A0		DMM Address

DMM ADDRESS	INSTRUMENT TYPE FOR THAT DMM ADDRESS
0	8 M D 9 E A 2 A T X S A A
1	
2	
3	
4	8 d 9 B 2 R X E A F
5	8 6 0 0 A
6	8 8 1 0 A
7	
8	
9	

Operation with More than One DMM

Two DMMs are connected to the DMM-GPIB Interface -- one 8600A and one 892XA type instrument. The following conditions are set:

1. Primary talk address of the DMM-1120A Interface PCB is 2.

2. The 8600A is measuring a +5V dc signal and the front panel controls are set to the following positions:

FUNCTION	DCV
RANGE	20
POWER	ON

3. The 892XA is measuring a 1.1V signal and the front panel controls are set to the following positions:

POWER	ON
AC/AC+DC	AC
AUTO/HOLD	AUTO
REL/dBm	dBm
dBm REFERENCE (Ω)	600

Enter the following program into the 4051:

```
100 INIT
110 PAGE
120 PRINT "<tab> DIGITAL VOLTMETER"
130 PRINT "      DATA COLLECTION VIA
IEEE-488"
140 PRINT "<tab>STANDARD INTERFACE"
150 PRINT
160 DIM P(10),S(10)
170 PRINT "ENTER NUMBER OF DEVICES";
180 INPUT N
190 PRINT "ENTER: PRIMARY, SEC-
ONDARY ADDRESSES"
200 FOR I=1 TO N
210 PRINT I;" ";
220 INPUT P(I),S(I)
230 NEXT I
240 PRINT "NUMBER OF READINGS(-1=
INFINITY)";
250 INPUT R
260 FOR I=1 TO N
270 INPUT @P(I),S(I):D,A$
280 PRINT D, A$
290 NEXT I
300 R=R-1
310 IF R=0 THEN 1000
320 PRINT
330 GO TO 260
1000 END
```

To request the 4051 to get three DMM measurements from both of the DMM:

```
RUN
        DIGITAL VOLTMETER
DATA            COLLECTION VIA IEEE-488
        STANDARD INTERFACE

ENTER NUMBER OF DEVICES: ? 2
ENTER: PRIMARY, SECONDARY ADD-
RESSES
1? 2,1
2? 2,2
NUMBER OF READINGS (-1=INFINITY)? 3
```

The 4051 screen will display, in sequence:

```
+3.01    , DB
+5.14    ,

+3.01    , DB
+5.14    ,

+3.01    , DB
+5.14
```

HEWLETT-PACKARD 9825

The basic input statement for the HP 9825 is red7PPSS, <variable> where PP is the primary talk address and SS is the secondary talk address. Both digits must be used for each talk address (i.e., a primary talk address of 5 would be entered os 05). Unless otherwise stated, the HP9825 must have both the "General I/O -Extended I/O" ROM and the "String- Adv. Programming" ROM. The HP-IB Interface I/O address switch should be set to 7.

Operation with One DMM

Enter dim A$[20]<execute> to allow A$ to be used as a string variable and to set the maximum string length. The following examples assume that the DMM-1120A Interface PCB Primary Talk Address is 0 and that the DMM is an 8600A measuring a +5V ac rms signal with the DMM front panel controls as follows:

POWER	ON
ACV	ON
20	ON

1. To get one DMM data message:

   a. Enter: <fetch>fo red70001,A$;dspA;<store>
   fo <execute>

b. The HP 9825 sends on the GPIB:

ATN UNL
ATN MLA 5

ATN MTA 0
ATN MSA 2

Then the HP 9825 waits for DMM data.

c. When the DMM-GPIB Interface sends the DMM data message, the HP 9825 screen displays 5.00, V .

d. Enter: <fetch>fo red70001,A$;cmd7,char (95);dspA$
fo <execute>

The command, cmd7,char(95) sends ATN and UNT on the GPIB. If ATN and UNT are not sent, the DMM-GPIB Interface will send the first data message then the first byte of the second data message and wait for the HP 9825 to respond. The HP 9825 will not respond until the next time <execute> is pressed. At that time, the DMM-GPIB Interface will repeat the first byte of the second data message (which was never accepted by the HP 9825) then finishes sending the message sequence. This message is the DMM data immediately following the first <execute>: it is not fresh DMM data and may not agree with the DMM display.

2. To get DMM data messages continuously, type:

<fetch>fo red70001,A$;dspA$;gto–0
fo <execute>

3. To get the DMM message in a form that can be used for further calculations (D is the numeric portion and A$ the alpha portion of the DMM data message) type:

fxd 9 <execute> (This keeps the millivolt readings from being rounded off into a meaningless 0.01 for display.)

<fetch>fo red70001,D,A$;cmd7,char(95);dspD, A$
fo <execute>

4. If your unit does not have the String-Adv. Programming ROM:

a. Type: <fetch>fo red70001,D;dspD

b. This will result in the following command and data sequence:

UNL
MLA
MTA
MSA
5.000, (DMM measurement data)
UNL
MLA
MTA
MSA
<space>V<CR><LF,END>

c. The unneeded sequence following the numeric data may be deleted by setting the "Suppress Alpha" solder-jumper on the DMM-1120A Interface PCB or by sending an OTA as in:

fo: red70001,A;cmd7,"U";dspA

Operation with More Than One DMM

The program below will collect and display data from more than one DMM or DVM which is connected the one DMM-GPIB Interface. In the example following the program, the primary talk address is 0 and one 8600A DMM and one 892XA DVM (secondary talk addresses 16 and 1, respectively) are connected to the DMM-GPIB Interface. Note that B$[N] is used only to identify the readings and can be any string within the constraints of the dimension statement.

PROGRAM:

```
0: dim A$[20],B$[10,10],P$[2],S$[2],V$[10]
1: dsp "DIGITAL VOLTMETER";wait 1000
2: dsp "DATA COLLECTION VIA IEEE-488";wait
1000
3: ent "Number of Devices?",N
4: dsp "ENTER: Device,Primary,Sec.";wait 1000
5: for I=1 to N
6: ent B$[I],P$,S$
7: dev B$[I],val("7&"P$&S$)
8: next I
9: for I=1 to N
10: red B$[I],V,V$
11: dsp B$[I],V,V$;wait 500
12: next I
13: gto –4
```

EXAMPLE:

```
 <RUN>
DIGITAL VOLTMETER
Data Collection via IEEE-488
Number of Devices? 2<continue>
ENTER: Device,primary,Sec.
 $[1]? 892XA <continue>
P$? 00 <continue>
```

```
S$? 01 <continue>
B$[2]? 8810A <continue>
P$? 00 <continue>
S$? 16 <continue>
```

The HP 9825 will now collect data from the two instruments and display each value for ½ second.

COMMODORE PET 2001- HOME COMPUTER

The PET requires an adapter to connect to the GPIB. The PET will not allow primary talk addresses of 0, 1, 2, or 3. Since the PET does not wait for the GPIB handshake with the DMM-GPIB Interface, it is necessary to test the status byte and repeat the input statement if data is not received. If this causes ATN to interrupt during a data transfer conversion period, the PET will have to wait for an additional DMM measurement cycle to be completed. The PET will hang-up if DMM measurement data does not appear on the GPIB (i.e., invalid address). In this case, you may have to turn the PET off losing the program stored in memory.

Operation with One DMM

Use the following program to request DMM data using the PET:

```
10 OPEN 1,4,1
20 INPUT #1,D$
30 IF ST<>0 THEN 20
40 PRINT D$
100 END
```

Operation with More Than One DMM

Once the program below has been entered, type RUN to use the program, then answer the questions as they appear. The program for operation with more than one DMM is as follows:

```
10 PRINT " DIGITAL VOLTMETER"
20 PRINT "DATA COLLECTION VIA IEEE-488"
30 PRINT " STANDARD INTERFACE"
40 PRINT"
50 PRINT " ENTER NUMBER OF DEVICES:";
60 INPUT N
70 PRINT "ENTER: DEVICE, PRIMARY,
SECONDARY
80 FOR I=1 TO N
85 PRINT I;
90 INPUT I$(I),P,S
100 OPEN I+3,P,S
110 NEXT I
115 PRINT "
120 PRINT "              DATA
130 PRINT "
150 FOR I=1 TO N
160 INPUT#I+3,D$
165 IF ST<>0 THEN 160
170 PRINT I$(I);" " :D$
200 NEXT I
210 PRINT
300 GOTO 150
1000 END
```

THEORY OF OPERATION

The DMM-1120A Interface PCB, as shown on the DMM-1120A Interface PCB schematic, contains an 8048 microprocessor, bus transceivers, control logic, and hard-wire program solder-jumper positions. The microprocessor addresses the DMM, collects DMM data, reformats the DMM data for the GPIB and transmits the DMM data in GPIB format using the three-wire handshake when properly addressed (MTA) by the GPIB Controller.

On power up or Interface Clear (IFC), the microprocessor pulls RADD (Not Read Address) low then lets RADD go high and pulls RSADD (Not Read Secondary Address) low. When RADD is low, the microprocessor checks the condition of the TALK ONLY solder-jumper position and reads and stores the primary talker address (same as MTA) from the position of the 1120A front panel controls and the position of the DMM-1120A Interface PCB in the 1120A. When RSADD is low, the microprocessor checks the INSTRUMENT TYPE/ADDRESS solder-jumper positions. If position 6 is shorted, the microprocessor reads and stores the MSA programmed on the 6 solder-jumper positions.

The microprocessor controls the direction of data flow on DIO1-DIO8 by means of TALKEN, except that RADD and RSADD also disable input from the DIO lines and ATN prevents conflict with a system controller by tri-stating the DIO output buffers. This hardware disable of GPIB outputs is necessary to meet timing requirements and allow proper communication between all interfaces in the 1120A which use the same set of GPIB buffers.

As soon as the microprocessor gets MSA -- either from the GPIB controller or from the solder-jumper positions -- it reduces MSA to the corresponding DMM Address, sends the DMM Address on A0-A3, and monitors AV (Not Address Valid). If there is no response on AV, the microprocessor will send ER<CR><LF,END> on the GPIB to indicate that an error has occurred. If AV goes low, the microprocessor will monitor DV (Not Data Valid) and collect one nibble of DMM data from the W, X, Y, Z lines each time DV goes low. Once each DMM measurement cycle, the microprocessor changes the DMM data into the GPIB format and checks the SUPPRESS ALPHA solder-jumper position. If SUPPRESS ALPHA is open, the GPIB message will contain the alpha portion of the message. If SUPPRESS

ALPHA is shorted, the GPIB message will not contain an alpha portion. If the controller asserts ATN during the time that the DMM-1120A Interface PCB is collecting or formatting data from the instrument, that data is lost and the controller must then wait for the instrument to make another measurement. The microprocessor cannot service the GPIB and simultaneously watch the instrument for new readings.

When the microprocessor receives an MTA from the GPIB Controller that agrees with its stored MTA, the microprocessor attempts to establish communication with the GPIB listener(s) via the three-wire handshake. When communication is established, the DMM data -- now in GPIB format -- is transmitted at a rate determined by the three-wire handshake. Once the DMM-1120A Interface begins to send a measurement value on the GPIB, it does not update the value until it has sent the full message sequence or has been untalked. If the GPIB Controller interrupts a message sequence with ATN, but does not send an Other Talk Address (OTA), the remainder of the message will be sent when ATN is removed. If the DMM-1120A Interface is connected to more than one instrument, and has been addressed as a talker, it is only necessary to send the secondary address to change from one instrument to another, provided the controller has not sent any Primary Command Group message other than MTA (i.e., DMM-1120A Interface in TPAS).

MAINTENANCE

WARNING

THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE EARLIER PORTION OF THIS MANUAL UNLESS YOU ARE QUALIFIED TO DO SO.

Soldering Precautions

Remove the pcb from the instrument. Complete required jumper connections by shorting adjacent jumper holes with a solder bridge (no wire is needed). Jumpers are easily removed by use of a solder sucker. Take care not to overheat the pcb (results in circuit land pattern peeling). The plated-through holes are intended to minimize this problem but may allow hot solder to drip into the instrument if solder is applied carelessly or in excess. Check the bottom side of the pcb after soldering any jumpers to be sure there are no shorts caused by excess solder.

PCB Handling Instructions

Observe the precautions presented on the Static Awareness sheet (located near the front of this manual) when handling the pcb assemblies or devices mounted on the pcb assemblies.

Troubleshooting

Most problems will occur because of improper location of solder-jumpers. Be sure that the DMM Digital Interface is being addressed so that the INSTRUMENT NO. solder-jumper line is pulled low. If there are still problems, check connections and supply voltages. Then use an oscilloscope to trace signals from the DMM to the microprocessor. Especially note the output waveforms from the opto-isolators. While they may be considerably distorted, RG' should not go low less than ½ as long as RG, and data on W, X, Y, Z should remain stable while RG' is low.

MANUAL CHANGE INFORMATION

To identify the configuration of the pcbs used in your interface, refer to the revision letter (marked in ink) on the component side of each pcb assembly. Table 5 defines the assembly revision levels documented in this manual with an X.

As changes and improvements are made to the interface, they are identified by incrementing the revision letter marked on the affected pcb assembly. These changes are documented on a supplemental change/errata sheet which, when applicable, is inserted at the front of the manual. To backdate this manual to conform to earlier assembly revision levels, perform the changes indicated in Table 5.

LIST OF REPLACEABLE PARTS

Tables 6, 7, 8, and 9 list the replaceable parts of the -521 and -529 Options. Figure 2, 3, and 4 illustrate these parts lists. Refer to Section 5 of the DMM Instruction Manual for additional information about ordering parts.

Table 5. Manual Status and Backdating Information

Ref Or Option No.	Assembly Name	Fluke Part No.	* To adapt manual to earlier rev configurations perform changes in descending order (by no.), ending with change under desired rev letter																						
			—	A	B	C	D	E	F	G	H	J	K	L	M	N	P								
	DMM Digital Interface PCB	471698	X																						
	DMM-1120A Interface PCB	503078	X																						

* X = The PCB revision levels documented in this manual.
● = These revision letters were never used in the instrument.
—= No revision letter on the PCB.

Table 6. 8600A-521 Final Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	8600A-521, FINAL ASSEMBLY FIGURE 2 (8600A-521)	ORDER	BY	OPTION 8600A-521.			
A-521	Ⓐ DMM DIGITAL INTERFACE PCB ASSEMBLY SEE FIGURE 3	471698	89536	471698	1		
H1	STANDOFF, NYLON	104174	89536	104174	2		
H2	SCREW, PHP, 6-32 X 3/8	334458	89536	334458	4		
H3	SPACER, #6	102905	89536	102905	1		
H4	SCREW, PHP, 4-40 X 1-1/2	156380	73734	19033	1		
H5	CONNECTOR KIT	448563	00779	552565-2	1		
H6	NUT, HEX 4-40	184044	74734	8033NP	1		
H7	SCREW, PHP, 4-40 X 1/4	256156	89536	256156	4		
H8	WASHER, SPLIT/LK, 6-32	110692	73734	1358	2		
H9	CABLE TIE	172080	06383	SST-1M	2		
H10	SCREW, 6-20 X 3/8	288266	89536	288266	2		
H11	WASHER, FLAT	340505	89536	340505	2		
MP1	DECAL, SPECIFICATION	380667	89536	380667	1		
MP2	BRACKET	503128	89536	503128	1		
MP3	DECAL, HANDLE	347401	89536	347401	2		
MP4	HANDLE	330092	89536	330092	1		
MP5	PAD, FOOT	338632	89536	338632	2		
MP6	CASE	503649	89536	503649	1		
MP7	COVER, STANDARD	414425	00779	552297-1	2		
W1	CABLE, I/F DIGITAL DMM (J602/P2)	503086	89536	503086	1		
W2	CABLE, I/F DIGITAL DMM (J1/P601)	503110	89536	503110	1		
Y7203	CABLE, INTERFACE	491001	89536	491001	1		
	MANUAL (NOT SHOWN)	510768	89536	510768	1		

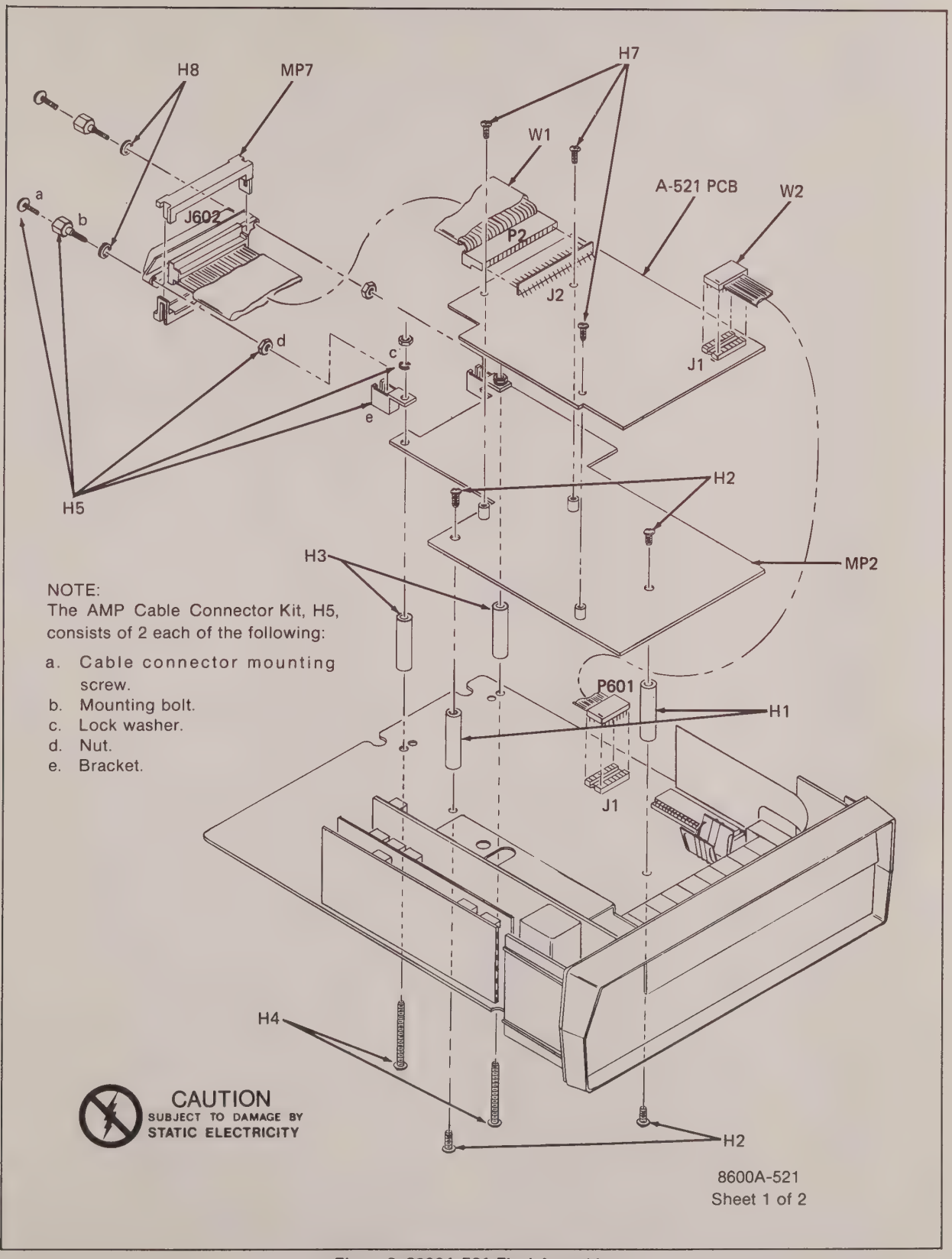


Figure 2. 8600A-521 Final Assembly

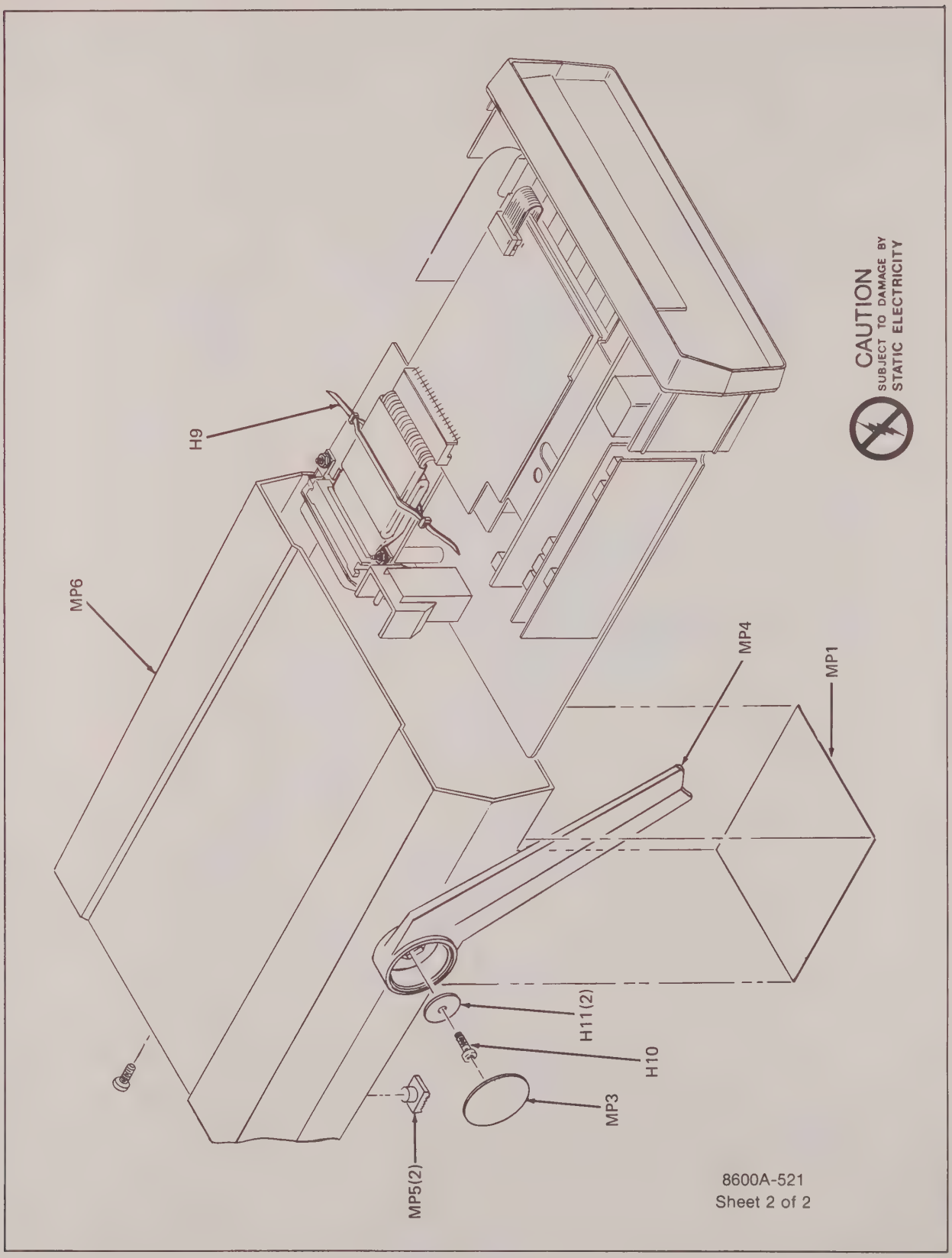


Figure 2. 8600A-521 Final Assembly (cont)

Table 7. DMM Digital Interface PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A-521	Ⓐ DMM DIGITAL INTERFACE PCB ASSEMBLY OPTION -521 FIGURE 3 (8X00A-4001T)	471698	89536	471698	AR		
C1	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	2		
C2	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C3	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	1		
J2	CONNECTOR, 18 POS., RT ANGLE P/H ASSY.	501254	00779	1-640099-8	1		
P1	SOCKET, 14-PIN	276527	91506	314-AG39D	1		
R1	RES, DEP CAR, 390 +/-5%, 1/4W	441543	80031	CR251-4-5P390E	6		
R2	RES, DEP CAR, 390 +/-5%, 1/4W	441543	80031	CR251-4-5P390E	REF		
R3	RES, DEP CAR, 390 +/-5%, 1/4W	441543	80031	CR251-4-5P390E	REF		
R4	RES, DEP CAR, 390 +/-5%, 1/4W	441543	80031	CR251-4-5P390E	REF		
R5	RES, DEP CAR, 390 +/-5%, 1/4W	441543	80031	CR251-4-5P390E	REF		
R6	RES, DEP CAR, 390 +/-5%, 1/4W	441543	80031	CR251-4-5P390E	REF		
R7	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	11		
R8	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R9	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R10	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R11	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R12	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R13	RES, DEP CAR, 470 +/-5%, 1/4W	343434	80031	CR251-4-5P470E	6		
R14	RES, DEP CAR, 470 +/-5%, 1/4W	343434	80031	CR251-4-5P470E	REF		
R15	RES, DEP CAR, 470 +/-5%, 1/4W	343434	80031	CR251-4-5P470E	REF		
R16	RES, DEP CAR, 470 +/-5%, 1/4W	343434	80031	CR251-4-5P470E	REF		
R17	RES, DEP CAR, 470 +/-5%, 1/4W	343434	80031	CR251-4-5P470E	REF		
R18	RES, DEP CAR, 470 +/-5%, 1/4W	343434	80031	CR251-4-5P470E	REF		
R19	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R20	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R21	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R22	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R23	RES, DEP CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	10		
R24	RES, DEP CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R25	RES, DEP CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R26	RES, DEP CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R27	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R28	RES, DEP CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R29	RES, DEP CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R30	RES, DEP CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R31	RES, DEP CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R32	RES, DEP CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R33	RES, DEP CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
U1	IC, TTL, HEX INVERTER	393058	01295	SN74LS04N	1	1	
U2	Ⓐ IC, C-MOS, DUAL D-TYPE F/F	340117	12040	MM5613AN	1	1	
U3	OPTO-ISOLATOR	504977	29083	MCT2E	6	2	
U4	OPTO-ISOLATOR	504977	29083	MCT2E	REF		
U5	OPTO-ISOLATOR	504977	29083	MCT2E	REF		
U6	OPTO-ISOLATOR	504977	29083	MCT2E	REF		
U7	OPTO-ISOLATOR	504977	29083	MCT2E	REF		
U8	OPTO-ISOLATOR	504977	29083	MCT2E	REF		
U9	Ⓐ IC, C-MOS, 3-STATE INVERTING BUFFER	454819	12040	MM80C98N	1	1	
U10	Ⓐ IC, C-MOS, QUAD 2-IN, NOR GATE	429944	12040	CD4001BN	1	1	
U11	Ⓐ IC, C-MOS, BCD TO DECIMAL DECODER	407981	12040	MM74C42N	1	1	

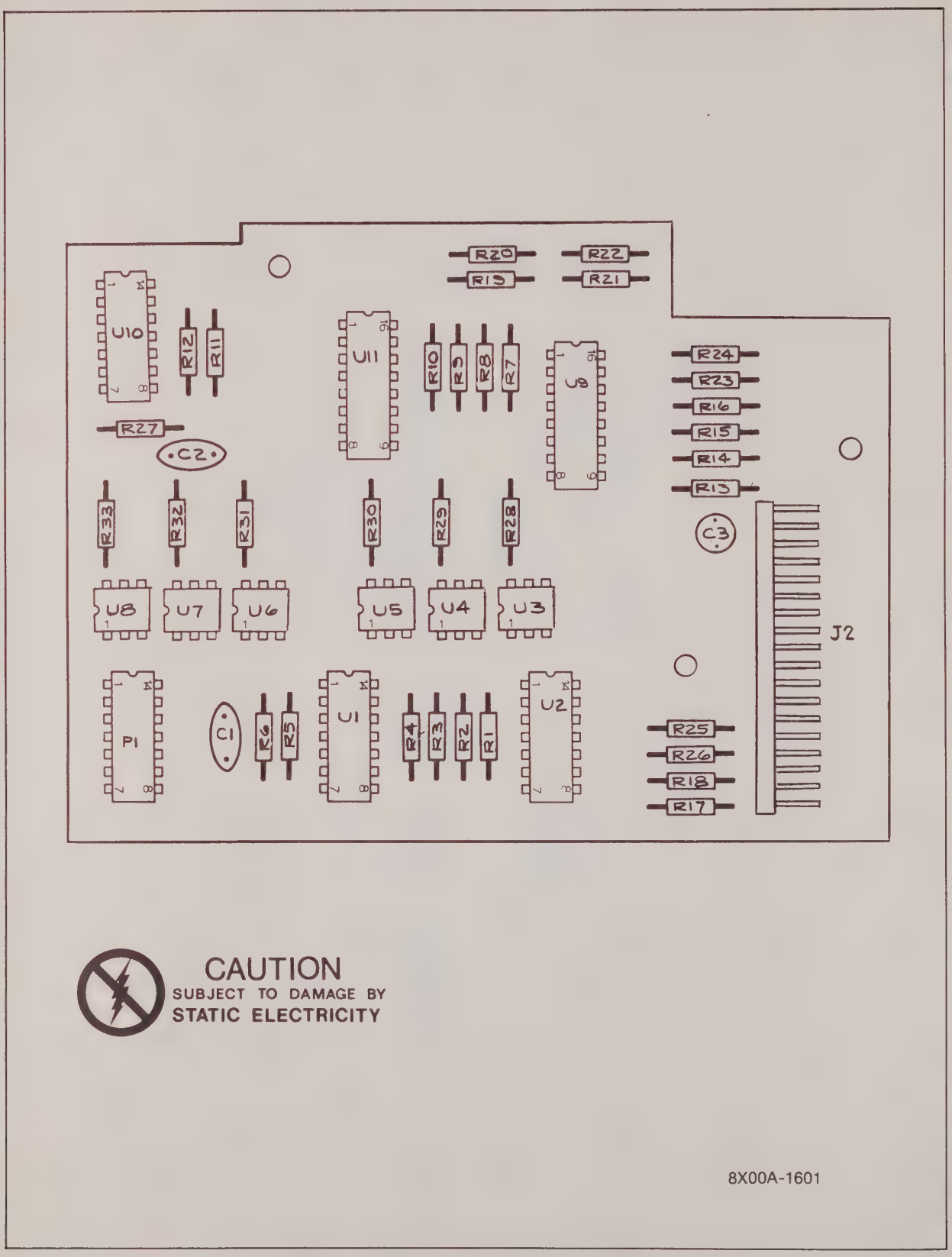


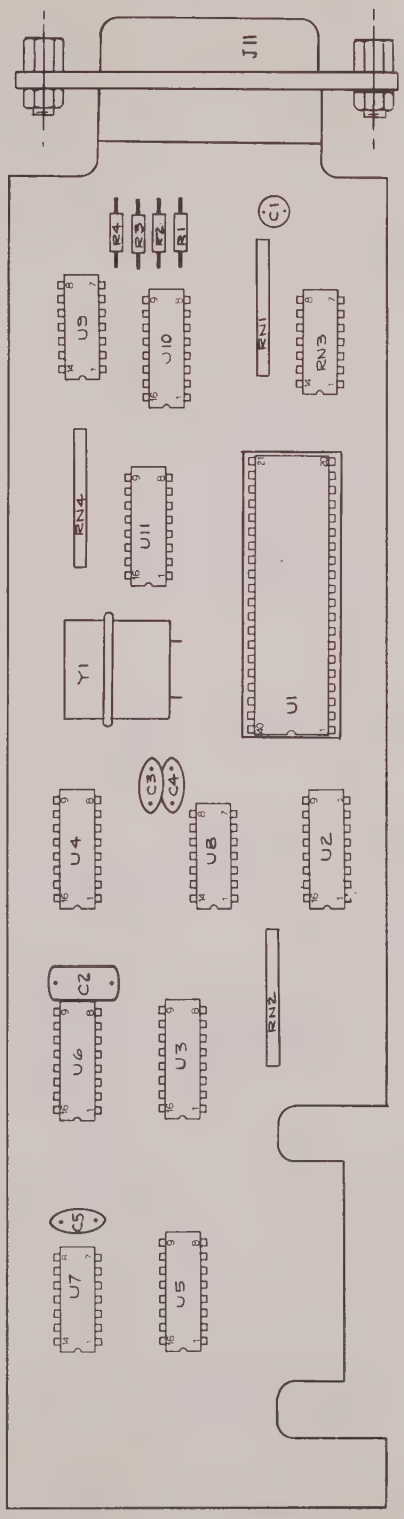
Figure 3. DMM Digital Interface PCB Assembly

Table 8. 892XA-529 Final Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	892XA-529 FINAL ASSEMBLY (NOT SHOWN)						
A-529	DMM-1120A INTERFACE PCB ASSEMBLY				1		
	-521 OPTION APPROPRIATE FOR DMM.				AR		

Table 9. DMM-1120A Interface PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A-529	Ⓟ DMM-1120A INTERFACE PCB ASSEMBLY DIGITAL MULTIMETER OPTION -529 FIGURE 4 (8X00A-4011T)	503078	89536	503078	1		
C1	CAP, TA, 2.2 UF +/-20%, 20V	161927	56289	196D225X0020HA1	1		
C2	CAP, MYLAR, 0.047 UF +/-10%, 250V	162008	73445	C280MAEA47K	1		
C3	CAP, CER, 20 PF +/-10%, 500V	106369	72982	831-000-T2H0-200K	2		
C4	CAP, CER, 20 PF +/-10%, 500V	106369	72982	831-000-T2H0-200K	REF		
C5	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	1		
H1	HARDWARE KIT	484196	00779	552568-1	1		
J11	CONN, PCB, MTG	484170	00779	552238-1	1		
MP1	STRAP, (ON Y1)	172080	06383	SST-1M	1		
R1	RES, DEP CAR, 470 +/-5%, 1/4W	343434	80031	CR251-45P470E	4		
R2	RES, DEP CAR, 470 +/-5%, 1/4W	343434	80031	CR251-45P470E	REF		
R3	RES, DEP CAR, 470 +/-5%, 1/4W	343434	80031	CR251-45P470E	REF		
R4	RES, DEP CAR, 470 +/-5%, 1/4W	343434	80031	CR251-45P470E	REF		
RN1	RES, NETWORK, 100K	461038	89536	461038	1	1	
RN2	RES, NETWORK, 10K	414003	89536	414003	2	1	
RN3	RES, NETWORK, 10K	364000	89536	364000	1	1	
RN4	RES, NETWORK, 10K	414003	89536	414003	REF		
U1	IC, CHIP MICRO-PROCESSOR	495077	89536	495077	1		
U2	Ⓟ IC, C-MOS, 3-STATE, INVERT/BUFFER	454819	12040	MM80C98N	6	2	
U3	Ⓟ IC, C-MOS, 3-STATE, INVERT/BUFFER	454819	12040	MM80C98N	REF		
U4	Ⓟ IC, C-MOS, 3-STATE, INVERT/BUFFER	454819	12040	MM80C98N	REF		
U5	Ⓟ IC, C-MOS, 3-STATE, INVERT/BUFFER	454819	12040	MM80C98N	REF		
U6	Ⓟ IC, C-MOS, 3-STATE, INVERT/BUFFER	454819	12040	MM80C98N	REF		
U7	IC, QUAD 2-INPUT POS NAND GATES	394205	01295	SN74LS03	1	1	
U8	Ⓟ IC, C-MOS, QUAD 2-IMPUT NAND S-TRIGGERS	404632	02735	CD4093BE	1	1	
U9	Ⓟ IC, C-MOS, HEX INVERTER	404681	02735	CD4069UBE	1	1	
U10	Ⓟ IC, C-MOS, TRI-STATE HEX NON-CNUT BFFRS	407759	89536	407759	1	1	
U11	Ⓟ IC, C-MOS, 3-STATE, INVERT/BUFFER	454819	12040	MM80C98N	REF		
XU1	SOCKET IC, 40-PIN	429282	09922	DILB40P-108	1		
Y1	CRYSTAL, 3.2 MHZ	460550	89536	460550	1		



8X00A-1611

Figure 4. DMM-1120A Interface PCB Assembly

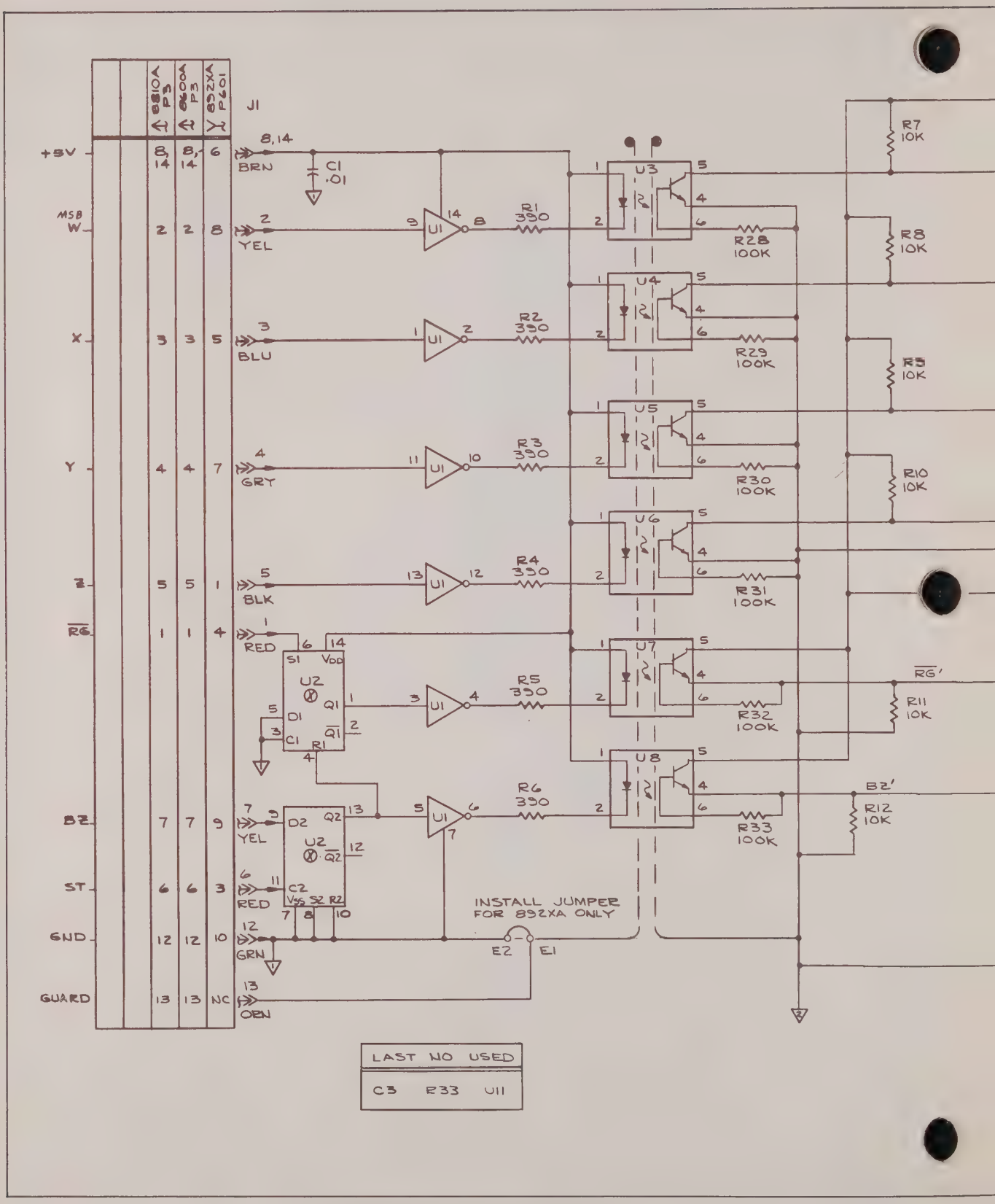


Figure 5. DMM Digital Interface PCB Assembly

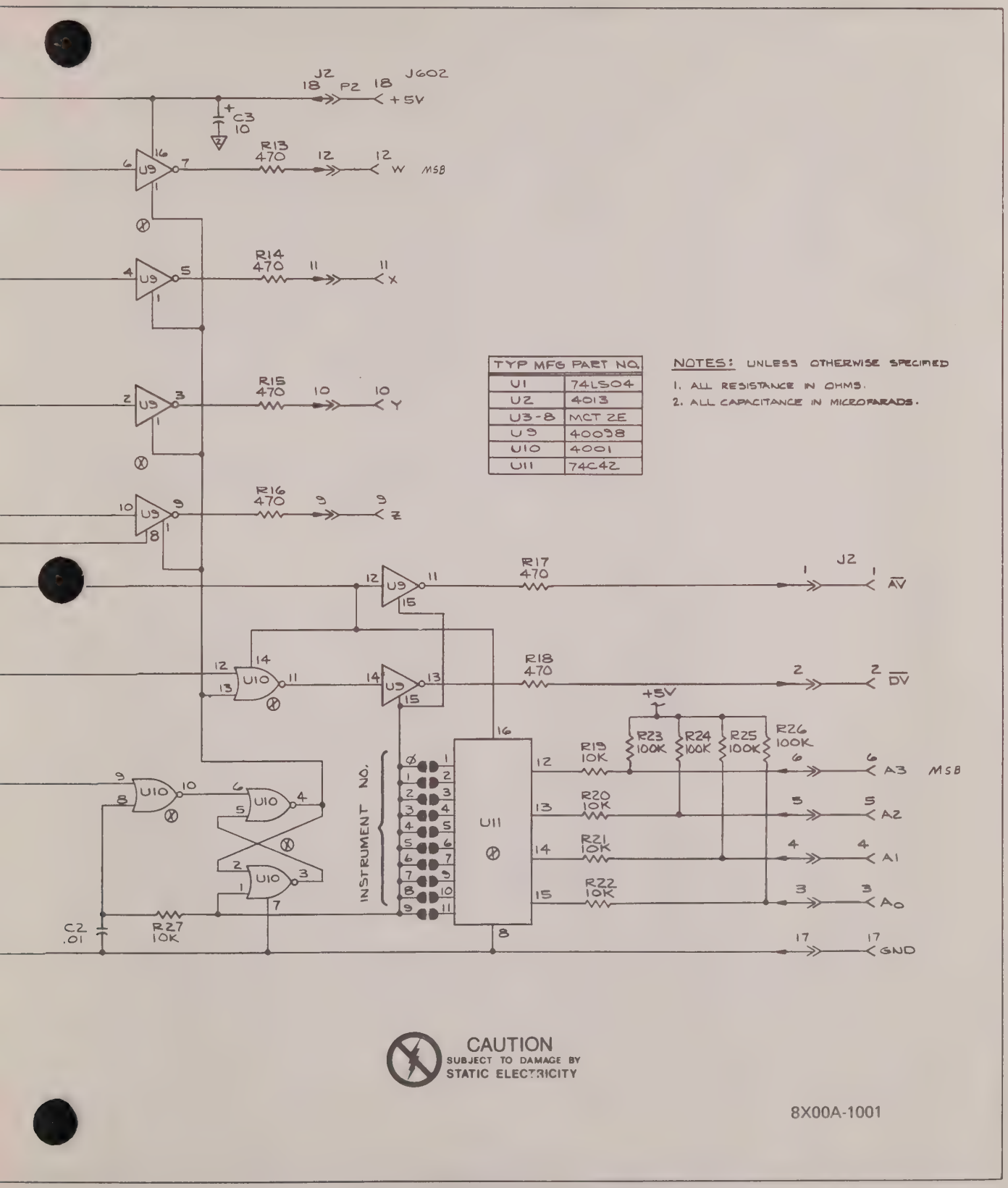


Figure 5. DMM Digital Interface PCB Assembly (cont)

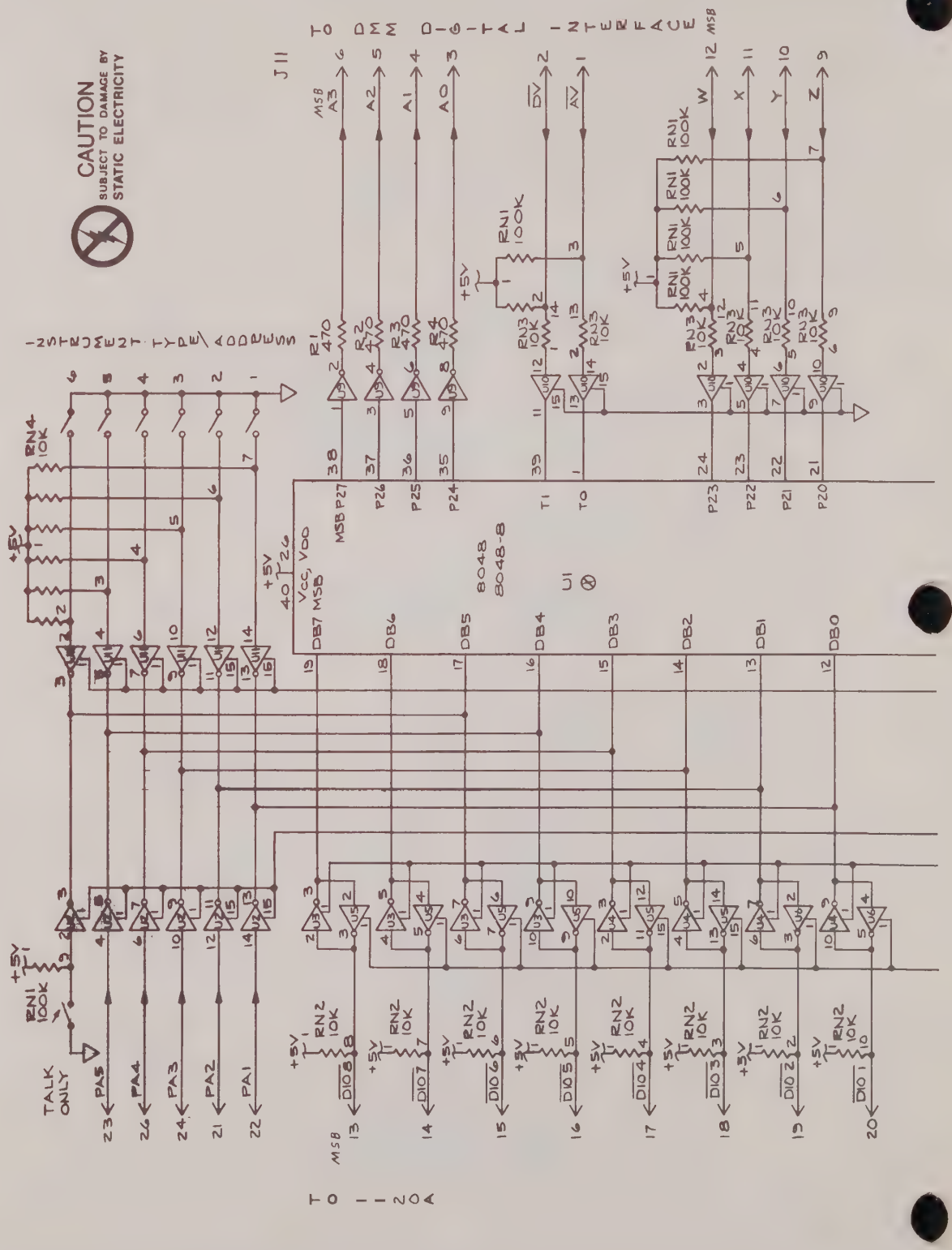


Figure 6. DMM-1120A Interface PCB Assembly

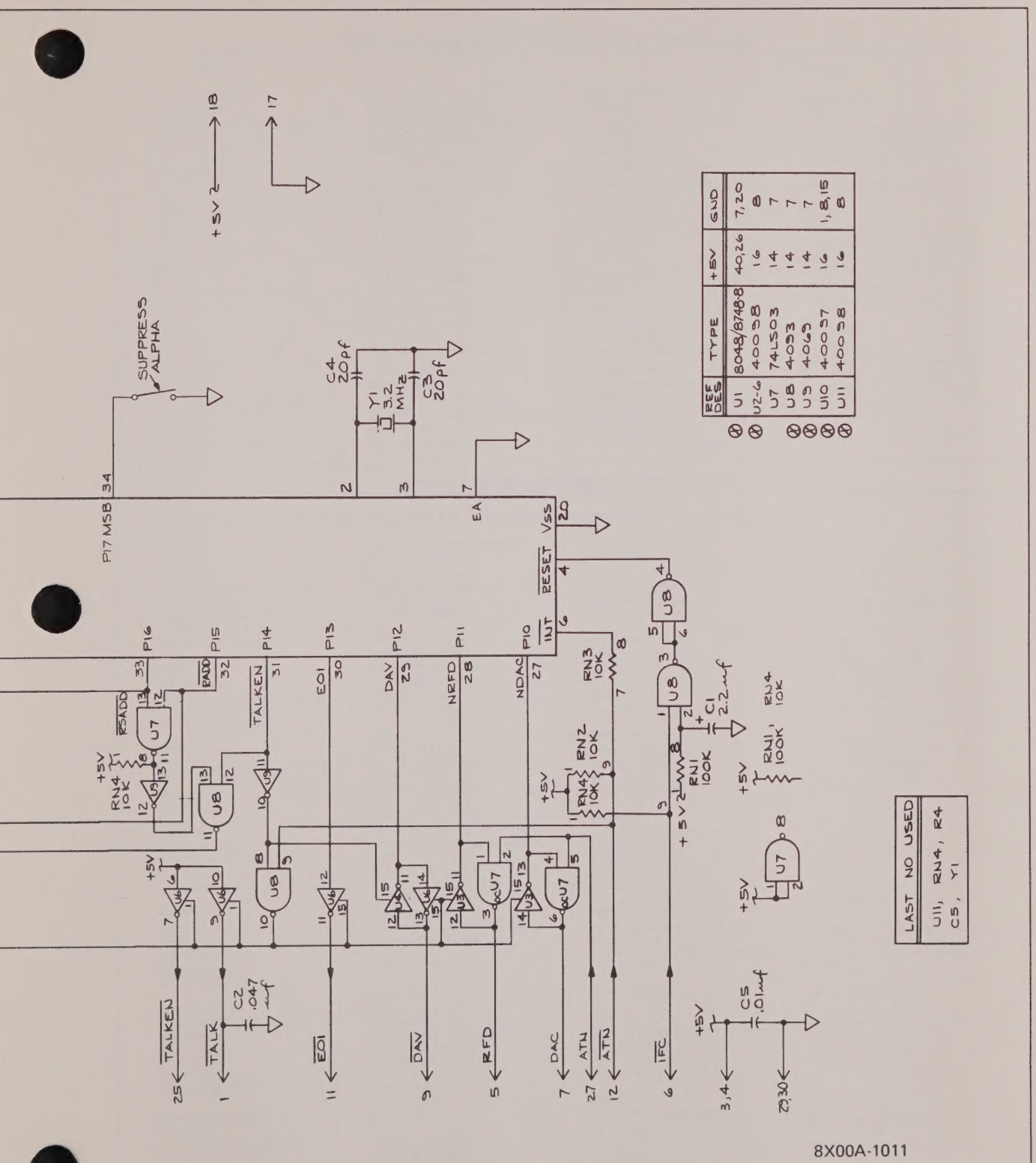


Figure 6. DMM-1120A Interface PCB Assembly (cont)

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